TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING & CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR:

DIPLOMA IN BUILDING AND CIVIL ENGINEERING

EBC 2307 : STRUCTURAL STEEL AND TIMBER DESIGN

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2016

TIME: 2 HOURS

DATE: Pick Date Dec 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

- Pocket calculator

-Bs 5950: Structural use of steelwork in buildings, part 1.

- Steel tables

This paper consists of **FIVE** questions. Attempt any THREE questions.

Do not write on the question paper.

Mobile phones are not allowed in the examination room.

Question One

(a) Describe three structural steel design methods. (8 marks)

(b) Describe six modes of failure considered in structural steel design. (12 marks)

Question Two

A 533x210x92 universal beam in steel grade S275 supporting 30Kn/m and 24 Kn/m characteristic dead and live respectively is simply supported over 100 mm bearings spaced 6.5m apart. Check the suitability of the beam in bending, shear and deflection. (20 marks)

Section properties: T=15.6mm,

D= 528.3 mm

B= 209.3 mm

T=10.2 mm

S_{xx}=2366cm^3

Question Three

(a) Define the following terms as used in timber design

i. Basic F
ii. Dry F
iii. Knot ratio (6 marks)

b) Describe the methods of timber stress grading. (4 marks)

(c) Design a suitable base plate to support 305x305x118 UC supporting 3000 Kn design load.

Section properties:

D= 314.5 mm B=306.8mm T=18.7mm t= 11.9mm

A=149.8cm^2 d=246.5mm Ryy=65.2mm Rxx=112mm

(10 marks)

Question Four

(a) Check the suitability of 100x65x8 mm angle iron for a truss member in steel grade S275.

Member max length=2207mm

Characteristic dead load (including self-weight) = 2.72 Kn/m

Characteristic imposed load=3.0 Kn/m

Make all necessary assumptions. (12 marks)

(b) Describe the necessary conditions for a but weld or fillet weld design strength be assumed to be same as of the parent material. (8 marks)

Question Five

Check the suitability of 75x300 mm deep timber grade C16 beam to effectively support uniformly distributed load of 3.5Kn/m inclusive of self-weight and resting on 200 mm bearing as shown below.

(20 marks)

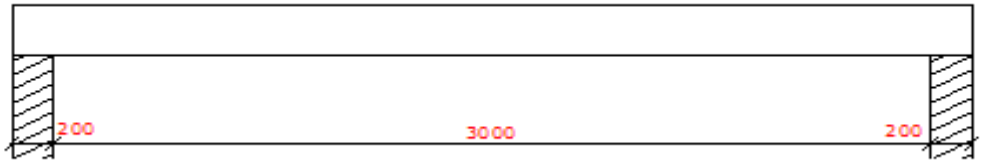


Table 6.3 Grade stresses and moduli of elasticity for various strength classes: for service classes 1 and 2 (based on Tables 8 and 9, BS 5268)

Strength class	*Bending parallel to grain* ($\sigma_{m,g,\|\|}$) *N/mm²*	*Tension parallel to grain* *N/mm²*	*Compression parallel to grain* ($\sigma_{c,g,\|\|}$) *N/mm²*	*Compression perpendicular to grain*[1] ($\sigma_{c,g,\perp}$) *N/mm²*	*N/mm²*	*Shear parallel to grain* (τ_g) *N/mm²*	*Modulus of elasticity* E_{mean} *N/mm²*	E_{min} *N/mm²*	*Characteristic density*[2] ρ_k *kg/m³*	*Average density*[2] ρ_{mean} *kg/m³*
C14	4.1	2.5	5.2	2.1	1.6	0.60	6 800	4 600	290	350
C16	5.3	3.2	6.8	2.2	1.7	0.67	8 800	5 800	310	370
C18	5.8	3.5	7.1	2.2	1.7	0.67	9 100	6 000	320	380
C22	6.8	4.1	7.5	2.3	1.7	0.71	9 700	6 500	340	410
C24	7.5	4.5	7.9	2.4	1.9	0.71	10 800	7 200	350	420
TR26	10.0	6.0	8.2	2.5	2.0	1.10	11 000	7 400	370	450
C27	10.0	6.0	8.2	2.5	2.0	1.10	12 300	8 200	370	450
C30	11.0	6.6	8.6	2.7	2.2	1.20	12 300	8 200	380	460
C35	12.0	7.2	8.7	2.9	2.4	1.30	13 400	9 000	400	480
C40	13.0	7.8	8.7	3.0	2.6	1.40	14 500	10 000	420	500
D30	9.0	5.4	8.1	2.8	2.2	1.40	9 500	6 000	530	640
D35	11.0	6.6	8.6	3.4	2.6	1.70	10 000	6 500	560	670
D40	12.5	7.5	12.6	3.9	3.0	2.00	10 800	7 500	590	700
D50	16.0	9.6	15.2	4.5	3.5	2.20	15 000	12 600	650	780
D60	18.0	10.8	18.0	5.2	4.0	2.40	18 500	15 600	700	840
D70	23.0	13.8	23.0	6.0	4.6	2.60	21 000	18 000	900	1 080

[1] When the specification specifically prohibits wane at bearing areas, the higher values may be used.
[2] For the calculation of dead load, the average density should be used.

Table 6.8 (*cont'd*)

*Customary target size** *mm*	*Area* $10^3 mm^2$	*Section Modulus* *About x–x* $10^3 mm^3$	*About y–y* $10^3 mm^3$	*Second moment of area* *About x–x* $10^6 mm^4$	*About y–y* $10^6 mm^4$	*Radius of gyration* *About x–x* *mm*	*About y–y* *mm*
75 × 100	7.50	125	93.8	6.25	3.52	28.9	21.7
75 × 150	11.3	281	141	21.1	5.27	43.3	21.7
75 × 175	13.1	383	164	33.5	6.15	50.5	21.7
75 × 200	15.0	500	188	50.0	7.03	57.7	21.7
75 × 225	16.9	633	211	71.2	7.91	65.0	21.7
75 × 250	18.8	781	234	97.7	8.79	72.2	21.7
75 × 300	22.5	1130	281	169	10.5	86.6	21.7
100 × 100	10.0	167	167	8.33	8.33	28.9	28.9
100 × 150	15.0	375	250	28.1	12.5	43.3	28.9
100 × 200	20.0	667	333	66.7	16.7	57.7	28.9
100 × 225	22.5	844	375	94.9	18.8	65.0	28.9
100 × 250	25.0	1010	417	130	20.8	72.2	28.9
100 × 300	30.0	1500	500	225	25.0	86.6	28.9
150 × 150	20.0	563	563	42.2	42.2	43.3	43.3
150 × 300	30.0	2250	1130	338	84.4	86.6	43.3
300 × 300	90.0	4500	4500	675	675	86.6	86.6

Note. * Desired size of timber measured at 20% moisture content

Table 6.9 Bending and shear deflections assuming $G = E/16$

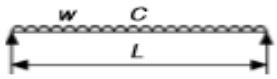
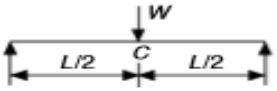
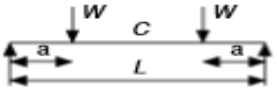
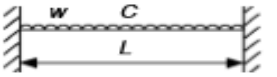
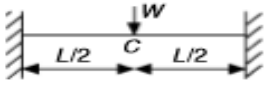
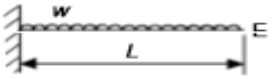
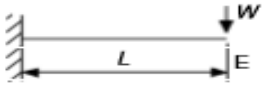
Load distribution and supports	*Deflection at Centre C or end E*	
	Bending	*Shear*
	$\frac{5}{384} \times \frac{wL^4}{EI}$	$\frac{12}{5} \times \frac{wL^2}{EA}$
	$\frac{WL^3}{48EI}$	$\frac{24}{5} \times \frac{WL}{EA}$
	$\frac{Wa}{EI}\left[\frac{L^2}{8} - \frac{a^2}{6}\right]$	$\frac{96}{5} \times \frac{Wa}{EA}$
	$\frac{wL^4}{384EI}$	$\frac{12}{5} \times \frac{wL^2}{EA}$
	$\frac{WL^3}{192EI}$	$\frac{24}{5} \times \frac{WL}{EA}$
	$\frac{wL^4}{8EI}$	$\frac{48}{5} \times \frac{wL^2}{EA}$
	$\frac{WL^3}{3EI}$	$\frac{96}{5} \times \frac{WL}{EA}$

Table 6.10 Maximum depth to breadth ratios (Table 19, BS 5268)

Degree of lateral support	*Maximum depth to breadth ratio*
No lateral support	2
Ends held in position	3
Ends held in position and member held in line, as by purlins or tie-rods at centres not more than 30 times the breadth of the member	4
Ends held in position and compression edge held in line, as by direct connection of sheathing, deck or joists	5
Ends held in position and compression edge held in line, as by direct connection of sheathing, deck or joists, together with adequate bridging or blocking spaced at intervals not exceeding six times the depth	6
Ends held in position and both edges held firmly in line	7